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ABSTRACT

Research dealing with specific aspects of individualized mathematics programs is summarized in this paper. Some explanations for the failure of self-pacing to result in superior achievement are examined. Studies dealing with student-teacher interaction in individualized programs are cited. Research with implications for new directions for individualization is reviewed. Finally, characteristics of successful students in self-paced programs are examined along with some alternate approaches to individualization. (Author/DT)

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INDIVIDUALIZED MATHEMATICS INSTRUCTION: WHAT ARE THE SPECIFIC PROBLEMS?

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Over fifty studies, primarily doctoral dissertations, comparing a self paced modularized approach to mathematics instruction with other instructional strategies have been conducted mostly within the last five years. Two recent summaries of this research show that not only have the individualized treatment groups consistently failed to achieve more in mathematics, they have much more often been outscored by students taught by the teacher centered approaches. With kindergarten to fourth grade level students, the individualized groups have usually outdone the control groups on affective measures. However, even this superiority has disappeared by grade five. In addition, there is some evidence that the longer an individualized program is in effect, the greater the differences in achievement become. These findings were consistently true with Individually Prescribed Instruction (IPI) and Westinghouse's Program for Learning in Accordance with Needs (PLAN), both developed, tested and revised by experts over the last eight to twelve years, as well as with teacher or researcher prepared materials (Schoen, 1975a; 1975b).

To make matters worse, the fact that extra expense is necessary to individualize instruction in this way was documented by numerous authors (e.g. Edmunds, 1971; Frary, 1971; Lipson, 1974). This expense factor makes the need for a demonstrable return in the form of student gains of some sort crucial to the survival of this instructional strategy. Most of the comparative studies were designed by the researchers to demonstrate such gains. Yet the results are little short of disastrous.

These findings should at the very least force mathematics educators to take a hard look at this mode of instruction. Where do the weaknesses lie?

Can and should an effort be made to develop improved versions of self pacing? What are the characteristics of students who succeed in these programs? In this paper research dealing with specific aspects of individualized programs is summarized. Some explanations of the failure of self pacing to show superiority are examined. Studies dealing with student-teacher interaction in individualized programs are cited. Research with implications for new and hopefully more fruitful directions for individualization is reviewed. Finally, characteristics of successful students in self paced programs are examined along with some alternate approaches to individualization.

Explaining the Poor Outcomes

Researcher's Conclusions

Grittner (1971) examined the individualization movement that reached its peak in the 1920s in this country. He pointed to the many similarities between that movement, which "died a natural death" in the 1930s, and the present one. Grittner concluded that four factors militate against this approach and that these factors will again lead self paced individualization to a "natural death."

(1) Cost and the fact that even the best programs do not improve achievement

(2) Heavy demand on the teachers' time and nervous systems

(3) Excessive amount of test taking time needed for student evaluation leaving very little time for learning

(4) Isolation of naturally social children

Whatever the reasons for the earlier failure, recent advances in measurement of educational and psychological variables, improved curriculum development

techniques borrowed in part from instructional programmers and the computer's instructional and management capabilities all serve to make individualized instruction at least potentially better today than it could have been in the early part of this century.

One of the first of the modern individualized programs was IPI, begun in Pittsburgh in 1963. IPI is a "model curriculum" which presumably utilizes the best of today's technology and learning theory. Nevertheless, Joseph Lipson (1974) who supervised the evaluation of the first version of IPI mathematics in the mid-1960s sounded amazingly like Grittner when he took a second look at IPI. He agreed that student isolation and teacher overload are major factors in the program's failure to produce the predicted student gains. In particular, Lipson blamed the absence of a means for the student to synthesize ideas in modularized systems, a function performed by a good teacher in a traditional classroom.

Other researchers concurred with Lipson and Grittner and added many other weaknesses of their self paced programs to the list. Dahlke (1975) conducted a case study of several adult community college freshmen in an individualized remedial mathematics course. The subjects all had basic misconceptions in mathematics and most had not been in a mathematics course for many years. According to Dahlke, students such as these had no chance to learn mathematics by this method since they needed guidance to aid in concept formation. Only students who possessed the basic concepts in advance seemed to gain from the review and drill provided by the self paced system.

Overworked teachers were reported to be a problem by many researchers (e.g. Nix, 1970; Osmundson, 1972; Palow, 1973; Sutton, 1967). Colvin (1973)

found that, in spite of inservice training, teachers often did not know how to function in the individualized mathematics classroom and, partly as a result of this, felt very isolated. Colvin also listed poor diagnosis, errors in packaging and the danger of becoming a drill and practice program as limitations of the Denver Continuous Progress Mathematics Program.

Some of the weaknesses indicated above have been further analyzed by researchers. These studies are summarized in the next section.

The Classroom Environment

This research is divided into three categories, (1) student-teacher interaction, (2) teacher-package interaction and (3) student-package interaction.

Student-teacher interaction

Neujahr (1971) videotaped three weeks of instruction in an individualized sixth grade mathematics classroom. He found that over 83% of the student-teacher talk was of assignments, materials and what the student should do next. Similarly, Sutton (1967) reported that in a typical hour seventh graders raised twice as many questions about procedural matters than they did about mathematics. On the positive side, Heiman's (1971) data suggested performance increased in individualized instruction only when the teacher read and reacted to the student's progress data in his presence.

If these are representative of individualized mathematics programs then clearly one major problem is the low educational quality of the student-teacher interaction. Heiman's recommendation is educationally sound but expensive in terms of extra teacher time or additional adult personnel in the classroom.

Teacher-package interaction

An assumption of most self paced programs is that students will benefit from being placed in the curriculum at their individual achievement level. In some programs an attempt is also made to place students in a mode of instruction that is assumed to be compatible with their individual personality and learning style. The mechanism for doing this is curriculum embedded diagnostic tests interpreted by the teacher following the curriculum developers' guidelines. Prescription procedures range from very specific matrices of objectives keyed to the test items to the teacher's judgment of the student's personality and/or learning style type.

Several studies raised serious questions about the validity of these assumptions. Holste (1972) compared four prescription strategies in seven primary IPI mathematics classrooms. Students whose teachers utilized the full array of prescription options recommended by the IPI developers scored lowest on the curriculum embedded mastery and retention tests. The other prescription techniques were (a) prescribing all activities in each unit to all students, (b) prescribing the minimum number of activities in each unit to all students, and (c) no prescription at all. Students in the last treatment scored the best on the mastery and retention tests while the on-task behavior of those doing the minimum number of activities was the best. Similarly, Snyder (1967) found no significant difference between the post achievement means of eighth graders who selected their own mathematical topics and those who were assigned topics by the teacher.

The ineffectiveness of teacher assessments of student personalities for purposes of prescribing a mode of instruction was demonstrated by Stiglmeier (1973). Eighth grade students who were rated by several teachers as highly

self-reliant or highly dependent were placed in self supportive (programmed instruction and independent study) and teacher supportive instructional modes (group work, tutor assistance and lab work), respectively. An initially equivalent group of eighth graders were randomly placed into self supportive and teacher supportive modes. Even though the students and teachers had been in an individually prescribed mathematics program for three years prior to the study, no significant mathematics achievement difference between matched and unmatched groups was found.

It seems likely that teachers will differ in their ability to make good prescriptions. However, DeRenzis (1971) found little difference between "control-oriented" and "freedom-oriented" teachers' ability to write good prescriptions nor did this ability improve with years of experience.

These findings indicate that diagnosis and prescription are two more areas in which self paced programs are not measuring up to predictions. In-service training, years of experience in teaching, and years of experience in individualized programs do not seem to improve a teacher's ability to make good prescriptions. In fact, arbitrary prescriptions or no prescription has been at least as effective as the "best" teacher-curriculum prescription strategies.

Student-package interaction

The assumptions made by curriculum developers concerning criterion performance levels and student in-class behavior were found to be inaccurate by two researchers. Oles (1973) inserted some plausible, but incorrect answers into the IPI mastery test keys. He then analyzed the behavior of 238 fifth graders on 1,282 individual self scoring ratings to determine the reliability

of student self scoring. The disappointing results are summarized in Table 1.

Table 1

Student Behavior	Percentage
Did not mark wrong and changed his answer to fit the key	18.5%
Did not mark wrong but skipped the problem	39.5%
Marked wrong but inserted the keyed answer without reworking	30.0%
Marked wrong, tried to rework and then saw teacher for help	12.1%

Oles also found that individual students were consistent in their behavior but that the intraclass self-scoring reliability was only .20. The "cheating" occurred equally with students at every achievement level. Random interviews with students indicated that they enjoyed self-scoring, admitted to cheating at times but did not think it was wrong.

Moncrief (1973) examined the validity of the a priori performance levels established for each unit in the Individualized Mathematics System (IMS). Elementary school students at several age levels were all advanced from one unit to the next whether or not the unit posttest score reached the required performance level. The students then completed the second unit, took the second unit posttest followed by a retest on the first unit. If the performance criterion was valid, students who failed to reach it on the first posttest should not be able to learn the material in the second unit, and completing the second unit should not raise the achievement level in the first. However,

Moncrief found that the optimum performance levels based on the second unit posttest and the retest of the first unit agreed with the IMS performance levels in only 15% of the units examined. He recommended that curriculum developers set performance criteria empirically and not in the usual a priori, "guesswork" manner.

Finch (1972) found that fourth and fifth graders performed best in a PLAN program when they utilized the multimedia options in the learning activities. However, most modules contained only one choice of instructional material and others had two, often with no multimedia option. For this reason and by both teacher and student choice, very little use was actually made of multimedia options.

In summary, the unreliability of student self scoring, the invalidity of pre-set performance criteria and the infrequent use of multimedia options even when they are available are three more weaknesses in the individualized systems.

Student Characteristics and Success in Self Pacing

This research and an earlier review by Suydam and Weaver (1970) indicate that all types of students are not equally successful in self paced mathematics programs. The relationship of individual student characteristics to success in these programs was examined by many researchers. Their findings are summarized in this section.

Chronological age

The summaries of the studies comparing self paced with teacher centered programs indicated that individualized groups compared less favorably with initially equivalent traditionally taught groups at the intermediate and

secondary levels than at the primary level. In particular, individualized groups in the primary grades scored higher on affective measures than the traditional comparison groups with little difference in achievement. On the other hand, individualized groups in grades five to eight scored below traditional groups on mathematics measures. The trend in achievement was very definitive while little difference was detected on affective measures. At the secondary level the same mathematics achievement trend was found though it was less definitive, and again differences in affective measures were not detected. The results at the post secondary level were too few for conclusions to be drawn (Schoen, 1975a; 1975b).

Based on these trends it appears that the chances of a successful self paced program are best with children in the primary grades and worst at the intermediate grade levels. In addition to the general trends, this conclusion is supported by the specific findingsof Abate (1973) and Neufeld (1968).

Self Motivation

Many researchers mentioned self motivation as an important factor in success in self paced programs (e.g. Schoen and Todd, 1974; Taylor, 1972). Dahlke (1974) found the student's reasons for enrolling in a self paced remedial community college mathematics course to be one of the best single predictors of success. Newman, et al (1974) reported similar findings among students in a college statistics course.

Aptitude and Past Achievement

Measures of previous mathematics achievement of community college students were among the best predictors of success in a self paced remedial mathematics

course (Dahlke, 1974). However, Wang and Lindvall (1970) were unable to consistently predict the success of children in grades two through six in IPI using aptitude measures (rate of learning in previous year and non-verbal IQ).

Several researchers found that students with high IQs and/or high achievement pretest scores learned well regardless of the instructional strategy employed. The mathematics achievement differences favoring teacher centered methods occurred primarily with weak to average students (e.g. Clough, 1971; Herceg, 1973; Larsson, 1973; Taylor, 1972; Wheaton, 1972). However, there was some evidence that low achievers in previous mathematics courses have a better attitude toward mathematics in an individualized program (Gaskill, 1971; Kulm, 1973).

Personality and Learning Style

Very little evidence of consistent differences in personality characteristics was found in three studies in which successful and unsuccessful students were compared following an individualized mathematics course. This was true with fourth, fifth and sixth graders (Neufeld, 1968), seventh and ninth graders (Malcolm, 1973) and college students (Newman, et al, 1974). In the last study, college students who procrastinated exhibited strong feelings of anonymity.

Cognitive style--flexibility of closure and undisciplined vs disciplined learning--was also found to be unrelated to success in individualized programs (Smith, 1973; Malcolm, 1973).

Reading

Malcolm (1973) found that reading skill was not related to the success of

seventh and ninth graders in an individualized mathematics program. However, Harper (1973) found IPI to be superior to both a teacher developed continuous progress program and a traditional approach with low reading ability fourth and fifth graders as measured by mathematics achievement. It seems very likely that the importance of reading ability is strongly dependent on the materials in the particular self paced program.

Sex

In his study of teacher pupil interaction in a sixth grade individualized mathematics classroom, Neujahr (1971) found that the average girl made 70% more moves than the average boy--twice as many reacting moves and 45% more responding moves. Girls also initiated 89% more interchanges with the teacher but the teacher initiated equally many moves with the boys and the girls. These results suggest that girls might do better than boys in individualized program.

Ferney (1970) found that to be true with fifth graders using PLAN. On the other hand, sixth grade boys in IPI showed a more positive attitude than boys in traditional classrooms, but a similar difference was not exhibited by the girls (Project Skill, 1972). Most researchers who considered sex as a factor found no significant main effect or treatment interactions (Broussard, 1971; Neufeld, 1968; Verheul, 1972; Wheaton, 1972).

Inner City Students

Broussard (1971) found IPI to be successful with inner city fourth grade students as measured by mathematics achievement. He also found no significant differences in achievement amoung four ethnic groups--Mexican American, black, white and other non-white.

Alternate Individualized Approaches

Several researchers tested the effects of variations on self paced programs in elementary schools. Some of these ended with no significant differences among the treatment groups (Chatterley, 1973; Frase, 1971; Hamby, 1972). Self pacing with supplementary use of manipulative objects was used successfully in elementary school mathematics programs as compared to self pacing without manipulatives (Bronder, 1973; Kamla and Shuman, 1968; Lindvall and Light, 1974).

Schoen (1974) adapted a mathematics course for future elementary school teachers to combine large group lectures for new content and learning packets for drill and review. No significant difference in achievement was found between a group of students taught by this combination and another group taught by the lectures and weekly in-class problem sessions. In another study involving college students, Matthews (1974) adapted a large self paced freshman mathematics program to allow for student choice of an instructor-tutor. Attitudes, but not mathematics achievement, improved with this approach.

After failing to demonstrate the superiority of their individualized strategies, several researchers made suggestions for modification. Some of these have been reported in previous sections. Other specific suggestions follow.

1. Use self pacing (in particular, IPI) to provide remediation for those who need it and to accommodate transfer students but not for the total instructional program (Lipson, 1974).
2. Instead of spending extra money to individualize, purchase equipment and activities designed to improve student attitude in the traditional classroom (Amendola, 1973).

3. Provide students with the option of individualized or traditional classrooms (Bull, 1971).
4. Instead of spending extra money to adopt a self paced program, hire teacher aides to help individual students or to take over some of the teachers "non-teaching" duties in the traditional classroom to allow her to work with individuals (Moody, 1972).
5. Instead of self pacing, provide basic instruction aimed at the formation of mathematical concepts comparable to elementary school teaching for the weakest remedial community college students (Dahlke, 1975).

Summary

Nearly one hundred studies designed to determine the overall effectiveness and to analyze specific aspects of self paced individualized mathematics programs were summarized in this and two previous papers. The findings are sketched briefly below.

1. Individualized programs are more expensive than traditional programs.
2. They are more work for the teacher.
3. Overall mathematics achievement is likely to be less in an individualized program than in a traditional one. In fact, achievement rate appears to decrease with each year of individualization.
4. Other student gains, such as those in the affective domain, have not been demonstrated except to some extent with primary grade children and slow learners.
5. Excessive amounts of test taking, isolation of the children and lack of a mechanism for students to unify the ideas to be learned are some problems mentioned by researchers.

6. The educational quality of the pupil-teacher interaction in the individualized classroom is very poor, consisting mostly of procedural matters.
7. The present techniques for diagnosis and prescription are ineffective.
8. Student self scoring is very unreliable, the pre-set performance criteria for the units may not be valid and multimedia instructional options are rarely used even when they are available.
9. Based on the trends of the comparative research, the chances of a successful self paced program are best with children in primary grades and worst at the intermediate grade levels.
10. A high degree of self motivation is a requisite for success in self paced programs.
11. High ability students usually do as well in a self paced program as in any other but average and below average students are likely to achieve less in these programs.
12. Personality characteristics and learning style have not been shown to be related to instructional method when self pacing is compared with teacher centered approaches.
13. The importance of reading ability is probably highly dependent on the materials in the particular self paced program.
14. Girls are more active in an individualized classroom (at least at the sixth grade level) than boys, but there is no consistent difference between boys' and girls' achievement or attitude in individualized programs.
15. One study showed IPI to be effective with inner city fourth graders.
16. Programs such as IPI, PLAN and IMS produced no better student outcomes than teacher made programs.

Discussion

A school already strongly committed to self paced mathematics instruction can profit from this identification of potential weaknesses in their programs. Suggestions such as those given at the end of the "Alternate Individualized Approaches" section seem to be very sensible for schools with no such commitment to individualization. Concern for the individual student's needs is indeed very important, but this approach to meeting those needs is (or at the very least, has been to date) generally ineffective. As the research showed, a major source of difficulties in self pacing lies in the need for the establishment of the entire instructional experience--objectives, diagnostic tests, mastery tests, criterion levels, prescription procedures, learning activities, instructional sequencing, etc.--prior in time to the actual instruction. Modification of the ongoing instructional experience by the teacher is only possible within the usually narrow range of the system's options. Yet as an active participant in the ongoing instructional process, the teacher is in a far better position, both in time and place, to make good decisions about individual student needs than even the wisest (but absent) curriculum developer. Thus, in spite of the presently popular rhetoric, a teacher should not feel she is necessarily failing to allow for individual differences if she decides not to adopt a self paced instructional approach. A whole myriad of classroom management problems coupled with the other cited difficulties can be and often are the undesirable outcomes of these programs to the detriment of group as well as individual learning.

REFERENCES

Abate, E. C. An Evaluation of an Individualized Educational System in an Elementary School. (Doctoral dissertation, Columbia University) Ann Arbor, Michigan: University Microfilms, 1973. No. 73-2575.

Amendola, A. A. Changes in Attitude and Achievement Effected by a Continuous Progress Educational Program at the Elementary School Level. (Doctoral dissertation, Arizona State University) Ann Arbor, Michigan: University Microfilms, 1973. No. 73-5304.

Bronder, C. C. The Application of Diagnostic Teaching to a Middle School Individualized Unit on Fractions. (Doctoral dissertation, University of Pittsburgh) Ann Arbor, Michigan: University Microfilms, 1973. No. 73-24, 091.

Broussard, V. The Effect of an Individualized Instructional Approach on the Academic Achievement in Mathematics of Inner-City Children. (Doctoral dissertation, Michigan State University) Ann Arbor, Michigan: University Microfilms, 1971. No. 71-31, 166.

Bull, S. S. A Comparison of the Achievement of Geometry Students Taught by Individualized Instruction and Traditional Instruction. (Doctoral dissertation, Arizona State University) Ann Arbor, Michigan: University Microfilms, 1971. No. 71-5976.

Chatterley, L. J. A Comparison of Selected Modes of Individualized Instruction in Mathematics for Effectiveness and Efficiency. (Doctoral dissertation, The University of Texas at Austin) Ann Arbor, Michigan: University Microfilms, 1973. No. 73-7532.

Clough, R. A. An Analysis of Student Achievement in Mathematics When Individually Prescribed Instruction (IPI) is Compared to the Current Instructional Program. (Doctoral dissertation, The University of Nebraska) Ann Arbor, Michigan: University Microfilms, 1971. No. 71-28, 604.

Colvin, D. Evaluation of CPMP (Grades 6-12 Continuous Progress Mathematics Program) 1972-1973. Final Report of an ESEA Title III Project, 1973. ERIC: ED 085400.

Dahlke, R. M. "Determining the Best Predictors of Success and of Time of Completion or Dropout in an Individualized Course in Arithmetic at a Community College." Journal for Research in Mathematics Education 5 (1974): 213-223.

Dahlke, R. M. "Studying the Individual in an Individualized Course in Arithmetic at a Community College: A Report on Four Case Studies." The Mathematics Teacher 68 (1975): 181-188.

De Renzis, J. J. An Investigation into the Attitude Patterns and Their Relationship to Prescription Writing Procedures of Teachers Using the IPI Instructional System in Elementary Mathematics. (Doctoral dissertation, Temple University) Ann Arbor, Michigan: University Microfilms, 1971. No. 71-10, 811.

Edmunds, J. "Individually Prescribed Instruction." Orbit 2 (June 1971); 10-13.

Ferney, G. A. An Evaluation of a Program for Learning in Accordance with Needs. (Doctoral dissertation, Washington State University) Ann Arbor, Michigan: University Microfilms, 1970. No. 70-5657.

Finch, J. M. Teaching-Learning Units in PLAN: An Analysis of the Utilization of Instructional Materials to Individualize Learning by Computer Managed Instruction. (Doctoral dissertation, The University of Iowa) Ann Arbor, Michigan: University Microfilms, 1972. No. 72-26, 675.

Frary, R. B. Formative Evaluation of the Individualized Mathematics System (IMS). Durham, North Carolina: National Laboratory of Higher Education, 1971.

Frase, L. E. A Comparison of Two Individualized Mathematics Programs on Student Independence, Achievement, Time, and Attitude Criterion Measures. (Doctoral dissertation, Arizona State University) Ann Arbor, Michigan: University Microfilms, 1971. No. 71-26, 592.

Gaskill, E. A. An Evaluation of Individually Prescribed Instruction in the Primary Grades of the Urbana Schools. (Doctoral dissertation, Illinois State University) Ann Arbor, Michigan: University Microfilms, 1971. No. 71-6003.

Grittner, F. M. "Individualized Instruction: New Myths and Old Realities." Wisconsin Journal of Public Instruction (Winter 1971): 49-59.

Hamby, K. D. A Model for Modifying Individualized Instruction. (Doctoral dissertation, The University of Texas at Austin) Ann Arbor, Michigan: University Microfilms, 1972. No. 72-19, 597.

Harper, K. J. A Comparison of Three Elementary Programs: A Model for Curriculum Evaluation. (Doctoral dissertation, Wayne State University) Ann Arbor, Michigan: University Microfilms, 1973. No. 73-12, 526.

Heiman, M. B. Individualized Instruction in the Classroom. (Doctoral dissertation, The University of Michigan) Ann Arbor, Michigan: University Microfilms, 1971. No. 71-4638.

Herceg, J. A Study of the Coordinator's Role in the Introduction of Formally Presented Objectives and Individualized Learning Rates in Computer Assisted Mathematics. (Doctoral dissertation, University of Pittsburgh) Ann Arbor, Michigan: University Microfilms, 1973. No. 73-4133.

Holste, D. E. The Effect of Different Prescriptions Used by Teachers in an IPI Mathematics Program. (Doctoral dissertation, The University of Illinois) Ann Arbor, Michigan, 1972. No. 72-19, 849.

Kamla, D., and E. Shuman. Research and Development Activities in R & I Units of Two Elementary Schools in Janesville, Wisconsin. Technical Report #45 of Wisconsin R & D Center of Cognitive Learning, 1968. ERIC: ED023175.

Kulm, G. The Effects of the Two Summative Evaluation Methods on Achievement and Attitudes in Individualized Seventh-Grade Mathematics. (Unpublished paper, Purdue University), 1973. ERIC: ED900279.

Larsson, I. "Individualized Mathematics Teaching Results from the IMU Project in Sweden." Studia Psychologica et Pedagogica Sersies Alters XXI, 1973. ERIC: ED082997.

Lindvall, C. M., and J. A. Light. The Use of Manipulative Lessons in Primary Grade Arithmetic in a Program for Individualized Instruction. Paper presented at The Annual Meeting of the AERA, 1974. ERIC: ED090038.

Lipson, J. I. "IPI Math--An Example of What's Right and Wrong with Individualized Modular Programs." Learning 2 (March 1974): 60-61.

Malcolm, P. J. Analysis of Attitude, Achievement and Student Profiles as a Result of Individualized Instruction in Mathematics. (Doctoral dissertation, The University of Nebraska) Ann Arbor, Michigan: University Microfilms, 1973. No. 73-121.

Matthews, F. F. An Investigation of the Feasibility of the Use of Student's Perceived Needs to Control the Rate of Instruction. Paper presented at The Annual Meeting of the AERA, 1974. ERIC: ED091227.

Moncrief, M. H. A Validation Study of Selected Decision Rules Used in the Management of Student Progress through an Individualized Mathematics System. (Doctoral dissertation, The Florida State University) Ann Arbor, Michigan: University Microfilms, 1973. No. 73-4695.

Moody, W. B. The Effect of Class Size on the Learning of Mathematics: A Parametric Study. Paper presented at The Annual Meeting of the AERA, 1972. ERIC: ED062138.

Neufeld, K. A. Differences in Personality Characteristics Between Groups Having High and Low Mathematical Achievement Gain Under Individualized Instruction. (Doctoral dissertation, University of Wisconsin) Ann Arbor, Michigan: University Microfilms, 1968. No. 67-16, 986.

Neujahr, J. L. An Analysis of Teacher-Pupil Interactions When Instruction is Individualized. (Doctoral dissertation, Columbia University) Ann Arbor, Michigan: University Microfilms, 1971. No. 71-5593.

Newman, F. L., D. L. Young, S. E. Ball, C. C. Smith and R. B. Purtle. "Initial Attitude Differences Among Successful, Proscrastinating, and 'Withdrawn-from-Course' Students in a Personalized Systems of Statistics Instruction." Journal for Research in Mathematics Education 5 (1974): 105-113.

Nix, G. C. An Experimental Study of Individualized Instruction in General Mathematics. (Doctoral dissertation, Auburn University) Ann Arbor, Michigan: University Microfilms, 1970. No. 70-1933.

Oles, H. J. "Assessment of Student Self-Evaluation Skills." Programmed Learning and Educational Technology 10 (1973): 360-363.

Osmundson, A. "Individualized Mathematics Instruction Through a System of Continuous Progress." The Mathematics Teacher 65 (1972): 417-420.

Palow, W. P. Modularization - - - a Road to Relevance. Paper presented at the meeting of the Florida Junior College Council of Teachers of Mathematics, 1973. ERIC: ED091232.

Project Skill -- Skill Development Through Individual Learning Levels. Final Report of an ESEA Title III Project, 1972, ERIC. ED082973.

Schoen, H. L. "A Plan to Combine Individualized Instruction with the Lecture Method." The Mathematics Teacher 67 (1974): 647-651.

Schoen, H. L. "Individualized Mathematics Instruction: How Effective Has it Been in the Elementary School?" Unpublished paper, The University of Iowa, 1975a.

Schoen, H. L. "Individualized Mathematics Instruction: How Effective Has It Been in Secondary and Post Secondary Schools?" Unpublished paper, The University of Iowa, 1975b.

Schoen, H. L., and R. M. Todd. "Teacher Prepared Learning Packages: Aid to Student? or Teacher?" Research Reporting Sections National Council of Teachers of Mathematics 52nd Annual Meeting (April 1974): 116-121.

Smith, G. E. The Relationship of Cognitive Style and Instructional Treatment and the Acquisition of Strategies for Teaching Elementary Mathematics. (Doctoral dissertation, The University of Texas at Austin) Ann Arbor, Michigan: University Microfilms, 1973. No. 73-520.

Snyder, H. D. A Comparative Study of Two Self-Selection-Pacing Approaches to

Individualizing Instruction in Junior High School Mathematics. (Doctoral dissertation, The University of Michigan) Ann Arbor, Michigan: University Microfilms, 1967. No. 67-8346.

Stiglmeier, L. M. Teachers' Judgments of Pupils' Dependence/Self-Reliance Characteristics, Mode of Instruction and Their Relationship to Achievement. (Doctoral dissertation, State University of New York at Albany) Ann Arbor, Michigan: University Microfilms, 1973. No. 73-19, 707.

Sutton, J. T. Individualizing Junior High School Mathematics Instruction: An Experimental Study. Final Report of Project No. 1365. Contract No. OE 2-10-083, 1967. ERIC: ED016609.

Suydam, M. N., and J. F. Weaver. Individualized Instruction, Set A, Using Research: A Key to Elementary School Mathematics. Pennsylvania State University Center for Cooperative Research with Schools, 1970. ERIC: ED038318.

Taylor, L. M. Independent Study versus Presentation by Lecture and Discussion: A Comparative Study of Attitude and Achievement in Two Algebra I Classes. (Doctoral dissertation, University of Northern Colorado) Ann Arbor, Michigan: University Microfilms, 1972. No. 72-3307.

Verheul, G. W. A Comparison of the Effects of Individually Prescribed Instruction and Conventional Textbook Instruction on Mathematics Learning of Selected Sixth Grade Students. (Doctoral dissertation, The Florida State University) Ann Arbor, Michigan: University Microfilms, 1972. No. 72-10, 052.

Wang, M. C., and C. M. Lindvall. An Exploratory Investigation of the Carroll Learning Model and the Bloom Strategy for Mastery Learning. Pittsburgh Learning Research and Development Center, 1970. ERIC: ED054983.

Wheaton, W. D. An Evaluation of an Individualized Learning Program in a California Union High School District. (Doctoral dissertation, University of Southern California) Ann Arbor, Michigan: University Microfilms, 1972. No. 72-11, 966.